Final Report for Period: 09/2005 - 02/2006
Submitted on: 02/23/2007
Principal Investigator: Bergin, Michael H.
Award ID: 0118579
Organization: GA Tech Res Corp - GIT
Submitted By:

Title:
Characterization of the Physical and Chemical Properties of Water Insoluble Atmospheric Aerosol

Project Participants

Senior Personnel

Name: Bergin, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Name: Carrico, Christian
Worked for more than 160 Hours: Yes
Contribution to Project:

Graduate Student

Name: Greenwald, Robert
Worked for more than 160 Hours: Yes
Contribution to Project:

Undergraduate Student

Name: Parks, Kristen
Worked for more than 160 Hours: No
Contribution to Project:

Name: Henson, Drew
Worked for more than 160 Hours: Yes
Contribution to Project:
Drew Henson is working on the project as an undergraduate research assistant. He is getting credits for his work as part of an undergraduate elective program. He is specifically working on determining the water insoluble size distribution of samples collected during a field study in France.

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Laboratoire de Glaciologie et Geophysiqu
LGGE in Grenoble France

Other Collaborators or Contacts

We have collaborated with the consulting company CT Associates that specializes in the measurement of particles in ultrapure liquids.

Activities and Findings

Research and Education Activities:

The water solubility of atmospheric aerosols is of key importance to their ability to impact climate (both directly and indirectly) and influence human health (through the accumulation in lungs and movement into the bloodstream). Currently the fraction of aerosol mass that is soluble in water is determined by extracting filters and measuring the change in filter mass. The procedure is time consuming, prone to measurement error, and must be done on filters that sample typically for 24 hours. The current methods also do not size differentiate aerosols, which is necessary to understand their impacts. To fill this gap we have developed a new technique to measure the size distribution (from 0.2 û 2.0 um) of water insoluble ambient aerosols. Our approach involved technique development and evaluation in the laboratory as well as several field field studies that took place in rural and urban Georgia and the high alpine region of France.

The activities involved a postdoctoral researcher, a PhD student (whose thesis was on the topic) and two undergraduate students. The work resulted in four peer-reviewed publications (Bergin et al., Geophys. Res. Lett., 2001; Greenwald et al., Environ. Sci. Technol., 2005; Greenwald et al., J. Geophys. Res., 2006; Greenwald et al., Atmos. Environ., 2007) and four conference presentations.

Findings:

The measurement technique was evaluated in the laboratory and it was found that the concentrations of a laboratory generated water insoluble aerosols (polystyrene latex spheres; PSL) could be sized and measured with a roughly 10% accuracy and precision (Greenwald et al., 2005). Field sampling was conducted in the Maurienne and Chamonix valleys of France during the winter and summer of 2003 as part of the Pollution des Vallees Alpines (POVA) experiment. A focus of this experiment was to determine the impact of mobile sources (e.g trucks) on air quality in these relatively pristine mountain environments. Our results indicated that on average water insoluble aerosols accounted for ~10% of the mass with a peak in the aerosol mass size distribution that occurred at roughly 0.5 um. Although during periods of heavy truck traffic during the evenings the insoluble mass could be as much as 60% of the total mass. The water insoluble mass was highly correlated with elemental carbon (EC) concentrations suggesting that the source of insoluble aerosol was cars and trucks moving up and down the valley (Greenwald et al, 2006).

Field sampling was also conducted in rural Georgia (Greenwald et al, 2005) and urban Atlanta (Greenwald et al., 2007) as part of the funded study. In urban Atlanta it was found that the water insoluble aerosol (WIA) was highly correlated with the real-time aerosol absorption coefficient. As in France, the results indicate that WIA is likely dominated by mobile sources. A great deal of variability was observed in WIA with a typical mass fraction of WIA on average of 5% with values as high as 40%. An additional finding was a dust event that was easily detectable due to a shift in insoluble mass to the supermicron range, and a significant increase in the WIA mass fraction. Overall, the field study showed that mobile sources generate a significant amount of WIA and that our instrument can readily detect dust versus anthropogenic sources of insoluble particulate matter.

Training and Development:

The project has involved the training of a postdoctoral researcher, PhD student, and two undergraduate students.

Outreach Activities:

The results of this project have been presented in several published papers and presentations as well as on our web pages. Research results have been presented in a number of undergraduate classes aimed at informing students about current research going on in the field of Atmospheric Science. This work has also been discussed during trips to local middle schools (e.g. Renfroe Middle School in Atlanta) where Bergin and his research group periodically go to discuss the atmosphere as well as the influence of pollutants on human and environmental health.

Journal Publications

Bergin, M.H., Greenwald, R., Xu, J., Berta, Y., Chameides, W.L., "Influence of aerosol dry deposition on photosynthetically active radiation available to plants: A case study in the Yangtze delta region of China", Geophys. Res. Lett, p. 3605, vol. 28, (2001). Published,

Greenwald, R., Bergin, M.H., Carrico, C.M., Grant, D., "A new real-time technique to measure the size distribution of water-insoluble aerosols", Env. Sci. Technol., p. 4967, vol. 39, (2005). Published,

Greenwald, R., Bergin, M.H., Jaffrezo, J.L., Bescombes, J.L., Aymoz, G., "Size-resolved, real-time measurements of water-insoluble aerosols in the Chamonix and Maurienne Valleys of alpine France", J. Geophys. Res., p. D09307, vol. 111, (2006). Published,

Greenwald, R., Bergin, M.H., Sullivan, A., Weber, R., "Size-resolved, real-time measurement of water-insoluble aerosols in metropolitan Atlanta during the summer of 2004", Atmos. Environ., p. 519, vol. 41, (2007). Published,

Books or Other One-time Publications

Web/Internet Site

URL(s):

http://www.ce.gatech.edu/~mhbergin,http://www.ce.gatech.edu/~mhbergin/robyaaar_pres.pdf

Description:

The first site (http://www.ce.gatech.edu/~mhbergin) is a general site that presents background information related to the PI, including a brief summary of this project. The second site (http://www.ce.gatech.edu/~mhbergin/robyaaar_pres.pdf) is a conference presentation on research being funded by the project.

Other Specific Products

Product Type:

Instruments or equipment developed

Product Description:

We have developed a new real time instrument to measure the size-resolved concentration of water insoluble aerosol (WIA) in the size range from 0.2-2.0 um.

Sharing Information:

The instrument may be useful for industrial applications that manufacture nano-materials and need a technique to quantify the size and concentration of these particles during the manufacturing process.

Contributions

Contributions within Discipline:

The project has developed a novel technique to measure the size resolved concentration of water insoluble aerosol particles (WIA). The water solubility of aerosols influences how they impact visibility and climate, and possibly human health. The project has the potential to significantly contribute to these areas.

Contributions to Other Disciplines:

At this time it is not clear how the project will contribute to other disciplines.

Contributions to Human Resource Development:

Several of the researchers/students trained in this project have went on to related activities. Dr. Kip Carrico (a postdoc on this project) is working as a research scientist at Colorado State University doing ambient aerosol related research. Dr. Roby Greenwald (PhD student) is now a postdoctoral researcher in Pediatric Medicine at Emory University. He is studying the influence of ultrafine particles on childrens health. Mr. Drew Henson (an undergraduate student who worked on the project) is a consulting engineer.

Contributions to Resources for Research and Education:

The technique developed as part of the funded efforts has been incorporated into a graduate level aerosol laboratory class.

Contributions Beyond Science and Engineering:

At this time there are no clear contributions to report.

Conference Proceedings

Categories for which nothing is reported:

Any Book
Any Conference